interior of the vessels F, F′, where cold water circulates. The boiling wort can be turned into the fermenting vats themselves, to which the cooling tubes alluded to have been added, besides covering over these vats with a tin cover by hydraulic pressure, or else the boiling wort will cool in a large apparatus F or F′, fitted with cooling tubes for the circulation of water; then, at the moment when fermentation begins, the wort is turned into the fermenting vats closed by their hydraulic covers. It is even possible to make the common refrigerators serve by enclosing them in a vessel full of carbonic acid gas, or of air deprived of germs, and even ordinary air, if the vessel is of small capacity.

"To recapitulate:—the main and altogether novel principle of my process consists in the employment of vats of tin or wood, into which the wort is run as hot as possible, and is cooled by a current of water outside, or outside and inside at once, without any evaporation, over which there is absolute control; so much is this the case that, according to the terms of my patent, nothing is more simple than to transport the wort without danger to the greatest distances. With regard to the action of the air, we can limit it at pleasure, in so far as it is noxious, for we can always annihilate the mischievous influence of the germs it contains. The brewer has, moreover, the control over the action of free oxygen gas, so far as it consumes the aromatic or other very delicate principles. Besides, my process allows the temperature to be kept steadily at any height for the purpose of fermentation. In short, its advantages are valuable for the fermentation of German beer, or for mild fermentation, for we can proceed to the employment of ice or any other powerful means of cooling during the process of fermentation. There, is, however, no distinction between strong and mild fermentation, except in so far as the greater or less specific differences of two yeasts, strong and mild, are concerned. The two yeasts can be kept equal; the fermentation will be accomplished in the cold vats.

"Ere long I shall indicate how we may obtain at pleasure, at all seasons, and in all places, the two yeasts in a state of purity, without having recourse to those of the brewer.

"The ferment which is deposited at the bottom of the vessels, F′, is of a brown colour, because it is mixed with the deposit characteristic of the wort during the cooling process. It will be easy to collect it almost white, and without mixture, either by scraping the surface of the cake which it forms at the bottom of the apparatus, or by introducing at the outset into the apparatus, at the moment when we place the cover on the boiling worts, circular plates, attached to a bar which passes through the cover. This upright bar should terminate in the quadrant of a circle, round the extremities of which it can be turned, and moved up or down. While the wort is cooling, the plate of each apparatus will have its plane in a vertical position, and thus it will remain during the first days of violent fermentation. Then, when the ferment begins to settle down, the plate should be gently lowered until it is horizontal. After the product has been drawn off, a cake of ferment will be found upon the plate."

M. Pasteur made still another addition to this process, which was added to his patent in January 1872. It is as follows:—

"When the yeast in one pan is spoiled from any cause, it is necessary to have recourse to yeast taken from another pan. It then becomes a matter of importance to be able to prepare for one's self in any kind of vessel whatever a yeast deprived of all deleterious germs. I have solved this problem by discovering that the *Mycoderma vini* can be made the nucleus of a mild yeast. It can be made to develop itself in the wort of beer sheltered from contact with the air. I have also discovered that the fermenting principle of the grape is a mild yeast. It is a source to which breweries established according to my process can resort."

This addition is, in my opinion, of great importance. M. Pasteur's researches will not probably end here. Every day brings with it a new idea. At all events, from this time the manufacture of beer has received such valuable improvements as will tend to its increased production and use. The process has not yet received the sanction of long experience, but it appears to have fulfilled all that was expected of it. Some have asserted that M. Pasteur's system involves an enormous expense. I do not believe it; experience will show these objections to be unfounded.

After all I know very well that M. Pasteur may yet be the victim of envy. It will be remembered what annoyance an enemy gave him in connection with his process for improving wines.

M. CHEVREUL

A VERY interesting episode took place at the *séance* of the French Academy of Sciences of September 2, on the occasion of what may be regarded as the academic jubilee of the Dean, the famous chemist, M. Chevreul. The fiftieth year of his membership does not strictly occur till 1876; but it is well known that he would have been elected in 1816, had he not urged the Academy to give the vacant place to M. Proust, his compatriot, and a celebrated chemist, who was old and infirm, and could not afford to wait. M. Faye, as president of the Academy, intimated that the members had resolved, as a token of their estimate of his works, and their regard for his personal character, to present the venerable Dean that day with a medal, without waiting for the arrival of the formal jubilee. The medal represents the features of the illustrious chemist, who bears the weight of his 86 years much more lightly than many of his fellows who are considerably younger than himself. M. Dumas, the celebrated chemist, and permanent secretary of the Academy, in an eloquent and gracefully-worded speech, recounted the many valuable services rendered by M. Chevreul, who modestly styles himself "le doyen des étudiants français," and at the same time bore warm testimony to the personal character of the man. After M. Elie de Beaumont, who had been a pupil of M. Chevreul, had added a few words of veneration and respect for his old master, the latter attempted to respond, but had simply to express his inability to do so. It was in 1806 that M. Chevreul published his first most important work. He was collaborator of Vanquelin: and he has just completed a volume, entitled "Mémoires de l'Académie," a most interesting work, which throws light upon many of the most scientific questions of the day. M. Chevreul is one of the most distinguished chemists of the age; and, besides being Dean of the Academy of Sciences, is Director of the Museum of Natural History at the Jardin des Plantes. He has chosen for his motto that beautiful maxim of Malebranche, which indeed affords a true key to his life, his works, and his discoveries, "*Chercher toujours l'infaillibilité, sans avoir la prétention de l'atteindre jamais.*"

NOTES

IT is stated, on the authority of a private telegram from Bombay of Tuesday last, that letters from Dr. Livingstone, dated July 2, 1872, have been received at Zanzibar. He was still at Unyamyembe, was well, and waiting the arrival of Stanley's second expedition.

THE fourth three-yearly meeting of the French Institute will take place on the 2nd of October, and the yearly public meeting on the 25th of October.

AT the sitting of the French Academy of Sciences, on Sept. 9, a number of communications on the subject of the ravages of the *Phylloxera vastatrix* in the vineyards of France were read by M. Dumas, and referred to the "*Phylloxera* committee" of the Academy. It appears that the disease is making fearfully rapid advances in Provence, threatening the speedy entire destruction of the crop. In the department of Vaucluse it is also rapidly increasing; while in that of l'Hérault it is rather diminishing. All the correspondents agreed that when once a plant is attacked cure is hopeless, and that it is almost impossible to prevent the parasite spreading to neighbouring plants by any other means than complete submersion under water, though the application to the roots of a soil composed of sand, manure, and some insecticide, will delay it for some years. There is no doubt that the wingless insect migrates above ground from the diseased to the healthy plant, and is carried in great quantities by the wind. M. d'Armand, of Marseilles, demanded that a prize of 500,000 fr., or, if necessary, 1,000,000 fr., be offered by the State to any one who shall discover a means of arresting the disease. The pest has made great advances also in Portugal, especially in the neighbourhood of Porto, Villa Réal, Douro, and Santarem; and a Royal Commission has been appointed to investigate fully the causes of a disease which threatens the destruction of one of the most important branches of national wealth, and the best means of curing it.

WE have received from New York copies of the *Tribune*, containing full reports of the A. A. A. S.—the transatlantic expansion of the British Association—contributed by one of the editors of that journal. There can scarcely be imagined a more striking indication of the root that Science is taking in America than this, for the report has necessitated some 2,400 miles of travel, and the white heat of a political contest is raging; and yet it appears: in other words, knowing the cleverness of our transatlantic cousins—it pays!

THE present excessive price of coals is stimulating the wits of every one concerned to endeavour to discover some means of reducing it. Certainly one of the best means would be to increase the supply from beneath the soil of our own country; how this may probably be accomplished is suggested in a letter to the *Liverpool Daily Post* of Sept. 16, by Mr. T. M. Reade, C.E. His suggestion is that in all likelihood coal would be found by boring the district immediately around Liverpool. The whole of the rock on which the town stands, and in fact the whole country, from a fault passing near and west of Neston, under the estuary of the Dee, to the Croxteth fault, just beyond West Derby, belongs to the Trias, which in this locality consists only of two members, the Bunter and the Keuper, the third, or Muschelkalk of Germany, being absent. Eastward the Triassic formation extends as far as Manchester, from which it follows an irregular line as far south as Shrewsbury; but as this portion of the district is deeply covered with the red marls of the Keuper, and as it would take deep sinking to reach the underlying coal (assuming it to be present), Mr. Reade confines his proposition to the district enclosed by lines drawn through Liverpool, Warrington, Chester, and West Kirby, at the mouth of the Dee. The whole of this district has been let down as in a trough, by which the Trias has, to a large extent, been preserved from denudation, and the underlying coal formation is consequently, in places, at a considerable depth below the surface; whether at a workable depth is the question which must be considered. Leaving out of account the red marls, which only occupy a small patch by Upton, in Cheshire, and again by the Weaver opposite Frodsham, the highest rock in the series is the Keuper sandstone, which forms the surface at Oxton, Wallasey, Heswell, and Stourton, in Cheshire, and under a portion of Liverpool, west of what is called the Everton fault—a strip of Keuper sandstone running almost due north from Toxteth Park. The remainder of the Triassic formation consists entirely of the Bunter sandstone, which is itself divided into Upper soft red sandstone, the pebble bed, and Lower soft red sandstone. Under these again, before we reach the highest members of the carboniferous rocks, it is an open question whether we should or should not have to penetrate Permian strata. The Permians have been proved in a few places, principally occurring on the northern boundary of the Trias in a narrow strip, and the total depth being but small. At Croxteth, where coal was formerly worked, the New Red sandstone or Trias is said to be directly superposed upon the coal measures; but a well-boring at Winwick, after penetrating 150 feet of red sandstone, the upper part of which is placed with the pebble beds in the geological survey sheet, was sunk 210 feet through strata consisting of hard red rock, stiff red marl, red and white sandstone, with a zone of limestone bands at the base, the boring terminating at 360 feet from the surface in hard rock. These beds, Mr. Reade is inclined to think, belong to the Permians rather than to the Upper coal measures; but it is doubtful if the Permians would be found under the whole area, as they have evidently been subject to denudation before the New Red sandstone was laid down. If coal is to be bored for at Liverpool, it should be at one of the several places where the Lower red sandstone is thrown up to the surface, the probability being, Mr. Reade thinks, that the upper members of the coal-measures would be reached at the depth of 400 or 500 feet, while the workable coal, or commencement of the middle coal-me asures, would probably be found at a further depth of 1,200 feet. If the shaft were sunk near a fault, it would soon be seen whether it were worth while to sink deeper. Mr. Reade suggests a patch of Lower sandstone, about half a square mile in extent, at Eastham, and a less one at West Kirby, in addition to that about Croxteth on this side of the river. The depth conjectured by Mr. Reade is very much under some of the depths which have been canvassed in estimates of the increased difficulty and costliness of meeting the industrial demand for fuel.

A GREAT international exhibition of fruit will be held at South Kensington, in connection with the Horticultural Department of the London International Exhibition, 1872, on Wednesday, Nov. 6, in which all home and foreign growers of fruit are invited to take part, and for which occasion a liberal schedule of prizes has been issued by the Council.

THE discovery of a new planet, No. 124, by M. Prosper Henry, on the night of September 11-12, is announced from Paris. Its position and motion are as follows:—September 11, $15^{m}\,47^{h}\,35^{s}$, Paris M.T.; R.A. $23^{h}\,59^{m}\,35^{s}$; Decl. $-0°\,55'\,57''$; horary motion in R.A. $-\,1^{s}\cdot9$, in Decl. $-\,20''$. Magnitude about 11·7.

DURING the closing hours of the last Congress of the United States an appropriation of 150,000 dols. was made for the purpose of introducing salmon, shad, and other valuable food fishes into the rivers and lakes of the United States, and its expenditure was placed in the hands of Professor Baird, the United States Commissioner of Fish and Fisheries. The late period at which this appropriation was made rendered it difficult to accomplish much in reference to shad, as the season for their hatching was very nearly over; but, notwithstanding this, a very satisfactory beginning to the enterprise is announced by the commissioner.

DR. AUGUSTUS KRANTZ, of Berlin, the well-known dealer in specimens of geology and mineralogy, died on the 6th of April last, in the sixty-second year of his age. This gentleman was well known throughout Europe and America for the immense collections kept for sale by him, and many colleges and other cabinets in the United States contain series purchased from him, furnished at very reasonable prices.

THE Newcastle-on-Tyne College of Physical Science has issued its prospectus for the Session 1872-73. The first Session closed with 70 day and over 100 evening students, and considerable accessions are hoped for. The teaching of Biology is still conspicuous by its absence; but there is so strong an element of Natural History on the governing board of the College that we may hope the just claims of this branch of science may not be disregarded much longer. Why is the obsolete term "Natural Philosophy" retained among the subjects taught? It is here apparently meant to embrace Mechanics, Hydrostatics, and Optics. An examination will be held on October 7 and 8 for four exhibitions of 15*l.* each, tenable in the College for two years, in Arithmetic, Algebra, and Euclid, and either Geology, Heat, or Chemistry.

IN 1871 the important papers of Dr. Petermann upon the Gulf Stream, with their accompanying maps and charts, were translated into English and published by the United States Hydrographic Office, under the direction of Captain R. H. Wyman. Since then two supplements have been issued by the office, including additional information obtained by Dr. Petermann, the second one accompanied by a map of the northern regions of Europe and Asia east of Greenland. This, which is on quite a large scale, gives us the results of the discoveries made up to the end of 1871, including the work done by Lamont, Mack, Johannesen, Payer and Weyprecht, Rosenthal, &c. The text of this supplement contains reports of the cruises of Smith and Ulve, and of Captain Torkildsen, papers on the sea north of Spitzbergen, and on Gillis's Land and King Charles's Land, &c. Petermann is of the opinion that, as far as the discoveries of land go, the results of Smith and Ulve are more important than those of any cruise between Greenland and Siberia for many years past, as they show that the north-east line of Spitzbergen extends across 10½ degrees of longitude instead of the 7½ previously assigned, this extension including the southern coast as well as the northern. The easternmost point reached by this expedition was a little beyond the 28th degree of east longitude.

AT no previous period (says *Harper's Weekly*) has there been so much activity displayed on the part of the United States Government in the way of thorough explorations of its territories, the liberality of Congress at the last session in authorising such having been very great. The operations of the Coast Survey have been largely extended, including the commencement of a triangulation between the coasts of the Atlantic and Pacific. Arrangements have been made for extended surveys by the Navy Department of the North Pacific, and an appropriation also made for the expense of making the observation of the coming transit of Venus. Under the War Department are progressing the new survey of the northern boundary of the United States, between the Rocky Mountains and the Lake of the Woods, the geological survey of Mr. Clarence King along the fortieth parallel, and the surveys in Utah and Nevada by Lieutenant George M. Wheeler; while Dr. Hayden's work in the Interior Department is advancing satisfactorily in its two main divisions, as also that of Major Powell along the Colorado.

THERE are at this time four chemical laboratories in Japan, where the science is taught, three of them being presided over by Germans and the fourth by an American. The chief one is at Osaka, where there are nearly 100 students. The rest are at Kaga, Shidzoka, and Fukuwi. A fifth will soon be opened at Jeddo. The students are said to be fairly intelligent, but their minds are at present encumbered with astrology and other kinds of spurious philosophy.

THE BRITISH ASSOCIATION

SECTION A—MATHEMATICAL AND PHYSICAL SCIENCE

On the Application of Photography to Copy Diffraction Gratings, by the Hon. J. W. Strutt.

GREAT interest has always attached itself to the beautiful phenomena discovered by Frauenhofer, which present themselves when a beam of light falls on a surface ruled with a great number of parallel and equidistant lines. Their unexpected character, the brilliant show of colour, and the ready explanation of the main point on the principles of the wave theory, recommend them to all; while the working physicist recognises in them the key to the exact measurement of wave-lengths, which has been so splendidly used by Angström and others.

The production, however, of gratings of sufficient fineness and regularity is a matter of no ordinary difficulty. Indeed, the exactness required and obtained is almost incredible. The wave-lengths of the soda lines differ by about the thousandth part. If in two gratings, or two parts of the same grating, the average interval between the divisions differed by this fraction, the less refrangible soda line of one would be superposed on the more refrangible corresponding to the other. In point of fact the gratings ruled by Nobert, to whom the scientific world has been greatly indebted, are capable of distinguishing a difference of wave-length probably of a tenth part of that above mentioned. But in order that the D lines may be resolved at all, there must be no average error (running over a large part of the grating) of $\frac{1}{1000}$ part of the interval between consecutive lines. When it is remembered what the interval is (from $\frac{1}{1000}$ to $\frac{1}{6000}$ of an inch, or even less), the degree of success which has been reached seems very remarkable.

A work requiring so much accuracy is necessarily costly—the reason, probably, why gratings fit to be used with the telescope for the purpose of showing the fixed lines are comparatively rare. The hope of being able to perfect a process for the reproduction of gratings at a comparatively cheap rate has induced me to return at the first opportunity to the experiments described in a preliminary note read before the Royal Society in June last. Although the subject is as yet by no means exhausted, I have thought it worth while to bring before the Section an account of the progress that has been made, with specimens of the results.

The method of procedure is very simple. A dry plate prepared by any photographic process on a *flat* surface of glass or other transparent material not affected by the fluid media employed, is brought into contact with the ruled surfaces of the grating in a printing frame, and exposed to light. In my first experiments I used exclusively as a source of light the image of the sun in a lens of short focus placed in the shutter of a darkened room; but so small a source is not necessary. The light from the clouds or sky, reflected by a mirror through a hole several inches in aperture, will be sufficiently concentrated if the frame be a few feet distant. I have not as yet specially investigated the point, but I believe that if the light were too much diffused the experiment would fail. Much would, no doubt, depend on the perfection of the contact—an element very likely to vary.

The variable intensity of diffused daylight, which it is almost impossible to estimate with precision, has induced me to use exclusively in my later experiments with ordinary photographic plates the light of a moderator lamp. This, with globe removed, is placed at a distance of one or two feet from the printing frame, the distance being carefully measured. Working in this way there is little difficulty in giving consecutive plates any relative exposures that may be required. A collateral advantage is the possibility of operating at any time of the day or night.

With regard to the preparation of the plates, I have latterly been using the tannin process introduced by Major Russell. A preliminary coating with dilute albumen is generally advisable, as any loosening of the film from the glass must be avoided, on account of the distortion that it might introduce. In some states of the collodion, an edging of black varnish put on after the exposure is sufficient to hold the film down. The glasses, after being coated with collodion (I have used Mawson's), are immersed as usual in the silver bath, and then allowed to soak in distilled water, best contained in a dipping-bath. They are then washed under a tap for about half a minute, and put into the tannin solution (about 15 grains to the ounce) held, in my practice, in a small dish. I usually prepare my plates in the evening, standing them up to dry on blotting-paper. In the morning they are in a fit state for use. Artificial heat might no doubt be used if a more rapid drying were desired.